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CALCULATIONS OF THE ECONOMIC EFFICIENCY OF DRILLING WELLS WITH SEPARATE OPERATION OF SEVERAL HORIZONS SIMULTANEOUSLY

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Abstract: the article presents a calculation of the economic efficiency of simultaneous development of several layers by one object. The necessary cost indicators of products on the domestic and foreign markets, taxes and payments, as well as expenditure, such as operational, capital costs when using the technology of dual completion (DC) and according to the traditional scheme are described and presented. The DC method is cost-effective and makes it possible to seal the grid of wells (producing and injection) without additional drilling footage and in increasing hydrocarbon production. Dual completion in the world practice of the development of multi-layer deposits is carried out in various ways, which are determined by the design of wells, the nature of separation of layers, types of technological operations of control and regulation of the development of operational facilities. Depending on the operating modes of the layers, the schemes of equipment for dual completion can be represented by the following combinations: fountain-fountain, gaslift-gaslift, pump-pump, injection-injection, fountain-pump, pump-fountain, fountain-gaslift, gaslift-fountain, etc. The effectiveness of dual completion in solving the tasks of the first group is characterized by ensuring optimal working conditions for each formation or the possibility of monitoring and regulating the development of formations. The number of wells in which the DC should be carried out is justified in the project, based on the need to solve these tasks. Evaluation of the effectiveness of the method by the amount of additional oil produced after the transfer of wells to dual completion is carried out only in frequent cases. Basically, with the planned and projected technological scheme of development, the use of the method, additional production should be taken into account when calculating development indicators.

When solving the tasks of the first group, the transfer of wells to DC can be carried out both from the very beginning of their commissioning, and after a certain period of joint operation of reservoirs.

Key words: packer, fountain-gas lift, income, depreciation, oil recovery, revenue, payback.

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1. Introductions

The positive effect of the use of the technology of DC is expressed in a reduction in capital investments for the construction of wells for each of the operational facilities, in a reduction in operating costs and the development period of a multi-layer field, in an increase in hydrocarbon production and the term of final oil recovery with cost-effective operation of wells.

2. Aim.

Let's determine the economic efficiency of the DC method of 4 wells at the Northern Goturdepe field.

Initially, in Table 1, it is necessary to provide initial data for calculating economic indicators for each studied well after applying the technology of DC (after implementation) and for comparison using traditional technology (before implementation) and their average value is determined [1, 2, 4].

Table 1.

Production volumes before and after the introduction of DC by wells of the Northern Goturdepe field

№№ in order	№№ wells	Period (before and after the introduction of the DC)	Oil production, thousand tons.	Liquid production, thousand tons.	Average value
1	2	3	4	5	6

3. Materials and methods

As mentioned above, the development of DC at the Northern Goturdepe field was carried out by 4 wells №№ 147, 37, 156, 200. Thus, the resulting volume of production (Q_{oil}) from these four wells after the DC test on this area allowed to reduce the number of wells to 8 units. Since it would take 12 wells to achieve the obtained oil production volumes according to the traditional scheme, and only 4 units according to the DC technology, that is, saving 8 wells [3, 7, 8, 9].

Based on the above facts, the additional annual production of commercial oil from the increase in final oil recovery for the implementation of this scientific development is calculated according to the following formula (1):

$$\Delta Q_{year} = Q_{after\,impl.} - Q_{before\,impl.}; \qquad (1)$$

Further, in order to conduct an economic assessment, it is necessary to cite the cost indicators of products on the domestic and foreign markets, taxes and payments, as well as expenses, such as capital expenditures when using the DC technology and according to the traditional scheme. In addition, operating costs will be required (including the costs of oil collection and transportation, technological preparation of oil, energy costs for oil extraction and other costs), the list of which is reflected in Table 2 below.

Table 2.

Initial data for economic assessment

№№ in order	Name	Unit of measurement
1	2	3
1	**Sale price**	
1.1.	The cost of oil on the domestic market without value added tax (VAT)	man/tn.
1.2.	The cost of oil to the foreign market	man/tn.
2	**Taxes and payments**	
2.1.	VAT	%
2.2.	Mineral extraction tax	%
2.3.	Income tax	%
3.1.	**Capital expenditures in the application of DC technology**	
3.1.1.	Well № 147	thousand manat
3.1.2.	Well № 37	thousand manat
3.1.3.	Well № 156	thousand manat
3.1.4.	Well № 200	thousand manat
3.2.	**Capital expenditures according to the traditional scheme**	
3.2.1.	Well № 201	thousand manat
3.2.2.	Well № 145	thousand manat
3.2.3.	Well № 202	thousand manat
4	**Operating costs (according to calculation items)**	
4.1.	Cost of oil production	man/tn.
4.2.	Oil collection and transportation costs	man/tn.
4.3.	Expenses on technological preparation of oil	man/tn.
4.4.	Energy costs for oil extraction	man/tn.
4.5.	Other expenses	man/tn.

Price is the most important economic parameter of any enterprise, it is the price level that affects its financial situation, since it determines the amount of profit received, plays the main structure–determining role, is the main link of the market self-regulation system [5, 6, 10].

After that, the calculation of economic indicators is carried out. Thus, using formula (2), we will determine the revenue from the sale of products. The revenue from the sale of products ($R_{s.\ of\ pr.}$) is calculated as the product of the selling price of oil and petroleum gas by their production volumes in the t–th year:

$$R_{s.\,of\ pr.} = P \times Q_{oil\,i}\ ; \qquad (2)$$

where **P** - is the price of oil without VAT, manat /ton;

Q_{oili} - oil production, thousand tons.

At the same time, 2 options can be considered here, the first, if we take into account the price of the domestic market, the second option when taking into account the cost of oil from the external market.

After the revenue from the sale of products has been determined, we find the profit from the sale of products. Profit from sales is the total income of the enterprise, reduced by the amount of operating costs, including depreciation costs and the total amount of taxes allocated to budgetary and extra-budgetary funds.

The balance sheet profit or taxable profit is determined by the following formula (3):

$$\mathrm{P}_{r.i} = \mathrm{R}_{\mathrm{s.of\,pr}_i} - O_{c\,i}\ ; \qquad (3)$$

In addition, as mentioned above, the positive effect of the use of DC is expressed in two directions, one of which is an increase in hydrocarbon production due to an increase in final oil recovery, and the second is a reduction in capital investments for the construction of operational facilities, in the amount of 8 units [11, 12].

Thus, we will determine the capital costs according to the basic (K_b) option, that is, according to the traditional scheme. Consequently, the economic efficiency of the implemented scientific development, which provides savings in capital costs, is calculated as follows:

$$K_{equip.} = P_{equip.} \times N_{w.s.i}\ ; \qquad (4)$$

Where **P_{equipi}** - cost of one equipment, thousand manats.

$N_{w.s.i}$ - well stock, well.

At the same time, the amount of capital expenditures for the implemented option ($K_{imp.}$) is taken into account from the cost of four wells with the DC technology (i.e. №№147, 37, 156, 200). As a result, the amount of economic efficiency from the reduction of capital costs for the construction of wells is determined by the formula (5):

$$E_{ef.} = K_b - K_{imp.}\ ; \qquad (5)$$

Thus, the total economic efficiency ($E_{ef.1}$) from the introduction of the scientific development of the DC without deduction of payments and taxes is further calculated according to the first option, which takes into account the price of oil sales on the domestic market, as well as according to the second option, taking into account the sale of oil to the foreign market ($E_{ef.2}$) [13, 14].

The next step in the economic assessment was the determination of income tax, which was carried out according to the formula (6):

$$T_{p.i} = P_i \times a_{p.}/100\%,\ \text{provided that } P_i > 0; \quad (6)$$

Therefore, the economic efficiency from dual completion implementation or sales profit after tax deduction are calculated according to the formula:

$$P_{s.of\ pr_i} = P_i - T_{p.i}; \quad (7)$$

It should be noted that the assessment of methods to increase the intensification of oil production was carried out in accordance with the current tax system of Turkmenistan (Table 3).

Table 3.

Rates of taxes and deductions to budget funds

Indicators	Unit of measurement	Values
VAT	%	15
Mineral extraction tax	%	10
Income tax	%	20

<u>Payments and taxes included in the cost of oil</u>

Mineral production tax:

$$C_{MPT_i} = Q_{oil_i} \times T_{MPT_i}; \quad (8)$$

Where $\mathbf{Q_{oili}}$ – oil production, thousands tons;

$\mathbf{T_{MPTi}}$ – mineral production tax rate, %;

<u>Taxes payable to the budget</u>

Value-added tax:

$$T_{V\text{-}A_i} = P_{oil} \times Q_{oil_i} \times a_{V\text{-}AT}/100\%; \quad (9)$$

Table 4 below shows the capital investments for the purchase of equipment. Since the amount of capital expenditures for the implemented option ($K_{imp.}$) is taken into account from the cost of four wells with the DC technology (i.e. No.147,37,156,200), their average value for 1 well is displayed.

Table 4.

Capital investments for the purchase of equipment, thousand manat

Well number	Capital expenditures in the application of DC technology	Capital expenditures according to the traditional scheme	Average value
1	2	3	4

4. Results and discussion

Cash flow

Discounted cash flow

Discounted cash flow is the sum of sales profit and depreciation charges less the investment value contributed to oil field development, and is defined as the amount of current annual cash flows reduced to the initial year. Discounted cash flow is determined according to the following formula:

$$NPV = \sum_{i=1}^{T} \frac{R_{s.i} - K_i - O_{c.i} - T_i + A_i}{(1+E)^{n=1}}; \quad (10)$$

Where NPV - discounted cash flow;
At - depreciation charges in t-th year;
Kt - capital investments in oil field development in t-th year.

The positive value of the net discounted income (NPV>0) is indicative of efficiency, as the sales proceeds are enough to recompense expenses and provide minimum required rate of return of this capital (equal of the discount rate - 15%).

Profitability index (PI)

Determination of the profitability index. The profitability index (PI) describes the economic return of investments and constitute the ratio of the total net income (oil sales profit and depreciation charges) and total discounted capital investments value:

$$PI = \frac{\sum_{i=1}^{T} P_{s.of\ pr_i} / (1+E_n)^{ti-1}}{\sum_{i=1}^{T} K / (1+E_n)^{ti-1}}; \quad (11)$$

If the profitability index is positive, as it was defined in the case of the dual completion at North Goturdepe field, where four wells numbered 147, 37, 156, 200 were examined, then it is the efficiency criteria, i.e. PI of the project [15, 16].

Payback period

The payback period may be determined from the following equation:

$$\sum_{i=1}^{T} \frac{(R_{s.of\ pr_i} - K_i - Oc_i - T_i + A_i)}{(1+E)^{n=1}} = 0 \quad (12)$$

Calculation of expenses

Gathering and transportation of oil:

$$C_{g.tr.of\ oil_i} = C_{g.tr.of\ oil} \times Q_{fl_i}; \quad (13)$$

Where $C_{g.tr.of\ oil_i}$ - costs for gathering and transportation of oil and gas, manats per ton of fluid;
$\mathbf{Q_{fii}}$ - fluid production from a reservoir, thous. ton.

Pre-processing of oil:

$$C_{p-p._i} = C_{p-p.} \times Q_{fl.r._i}; \quad (14)$$

Where $\mathbf{C_{p.-p}}$ - costs for pre-processing of oil, manat/t;
$\mathbf{Q_{fl.ri}}$ - volume of produced oil for pre-processing, thous. ton.

Energy costs for fluid extraction:

$$C_{extr_i} = C_{extr_i} \times Q_{mech._i};\qquad(15)$$

Where $\mathbf{P_{exti}}$ – energy costs consumed for fluid extraction, manats per ton of fluid;
$\mathbf{Q_{mechi}}$ - mechanized extraction of fluid, thous. tons.

Other costs:

$$C_{other} = C_{extr._i} \times Q_{fl._i};\qquad(16)$$

Where $\mathbf{T_{other}}$ - expences for various needs, depreciation, wages, social insurance and others, thous. manat;
$\mathbf{Q_{fli}}$ - fluid production from a reservoir, thous. ton.

Total current costs (excluding taxes and payments):

$$C_i = C_{g.tr.of\ oil_i} + C_{p.-p_i} + C_{extr_i} + C_{other_i};\qquad(17)$$

Production cost of 1 ton of oil (C_p):

$$C_{p.oil_i} = O_{c_i} \div Q_{oil_i};\qquad(18)$$

Accordingly, the indicators before and after the introduction of the DC equipment should be indicated in Table 5 below [3].

Table 5.

Indicators before and after the introduction of DC equipment, thousand mans

Name of indicators	Values
Period	
Energy costs for oil extraction	
Oil collection and transportation costs	
Costs of technological preparation of oil	
Mineral production tax	
The cost of the DC	
Costs before/after the DC	
Profit	

5. Conclusions

In the final part of the evaluation of the economic efficiency of improving the efficiency of development due to the DC at the North Goturdepe field, where 4 wells №147, 37, 156, 200 were investigated, an analysis of the economic efficiency of the use of DC was given (Table 6).

Table 6.

Economic efficiency from the introduction of DC technology

Name of indicators	Values
Additional oil production, thousand ton	
Additional liquid extraction, thousand ton	
Revenue, thousand manat	
Capital expenditures, thousand manat	
Operating costs, thousand manat	
Profit due to increased production, thousand manat	
Profit due to cost reduction, thousand mans	
Total profit, thousand manat	
NPV, thousand manat	
PI	
Payback period, years	

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